Glycemic Control and Type 1 Diabetes Mellitus: Current Standard Treatment vs. Closed-Loop Insulin Pumps

Kelsey Daley
University of North Dakota
Glycemic Control and Type 1 Diabetes Mellitus: Current Standard Treatment vs. Closed-Loop Insulin Pumps

Kelsey Daley, MPA-S
Department of Physician Assistant Studies, University of North Dakota School of Medicine & Health Sciences
Grand Forks, ND 58202-9037

Abstract

- Of 423, 9, 423 of the US population had a diagnosis of Diabetes Mellitus (DM). Although most of the data which describes type 1 (T1) and type 2 (T2) DM data in all ages of patients, the focus of this project will be on T1DM.

- There are effective methods currently available for the management of T1DM patients. These methods include: closed-loop insulin pumps that integrate a continuous glucose monitor (CGM) and insulin pump into one effective system that calculates the needed insulin doses through complicated algorithms, CGM with self-blood glucose monitoring (SBGM) and insulin administration, and SBGM with insulin administration.

- Literature reveals that closed-loop insulin pumps have the potential to provide better disease management and improved outcomes for those patients who are motivated to use them as directed and find them a desirable option.

- When patients can effectively manage their blood glucose, and practice healthy lifestyle and dietary choices, they can avoid unnecessary hospitalizations and long-term diabetic complications. This will substantially reduce healthcare-related costs, increase longevity and can improve the patient’s quality of life.

Introduction

- According to the CDC, DM affects 30.3 million people in the US. Five percent of all adults had systolic BP of 140 mmHg or higher and diastolic BP of 90 mmHg or higher, or 73.6% had a HgbA1C value higher than 9%.

- The DCCT performed by Nathan, et al. (2013) demonstrated a drop of nearly ~2.5% in microvascular side effects of retinopathy, nephropathy, and neuropathy, as well as the macrovascular side effects of stroke, cardiovascular disease, and cerebrovascular disease.

- Literature reveals that closed-loop insulin pumps can be integrated into diabetes management for the treatment of T1DM patients. This system has been shown to improve glycemic control and decrease hypoglycemic events and hospitalizations. Clinicians must be mindful of what type of insulin delivery system that they are recommending for each patient.

DIABETES MELLITUS type 1

- Current medical treatment for diabetic patients require self-blood glucose monitoring, this monitoring is done using self-blood glucose monitors (SBGM), which results in many finger sticks.

- Insulin injections can be performed by the patient or by an insulin pump that must be manually programmed, which requires the patient to be proficient at calculating insulin doses independently. There is a high potential for error related to insulin administration due to incorrect calibration of the glomerator or basic human error.

- When patients practice good blood glucose management they can avoid unnecessary hospitalizations and other diabetic complications, which will substantially reduce healthcare-related costs. These choices should be based on scientific evidence of effectiveness, not unreliable reports and should be made after considering the patient’s lifestyle and its impact on each method’s particular benefits and challenges.

- The CDC (2017) states that in 2014, a total of 3.5 million hospital discharges and 14.7 million emergency department visits were reported with diabetes being listed as any kind of diagnosis among US adults aged 18 years or older. The total direct and indirect economic cost of diabetes in the US for 2013 was $245 billion; with an average of 730,000 per person being medical expenditures related to diabetes. This is third times higher health-care expenditures for people without diabetes. It is also important to note that DM was the seventh leading cause of death in the US in 2017.

Research Questions

- Will closed-loop insulin pumps provide better efficacy by monitoring glycemic control according to patient’s blood glucose levels and glycated hemoglobin levels (HgbA1C) and decrease the incidence of hypoglycemic episodes, as compared to the current standard treatment of insulin pump therapy in patients with T1DM?

- What are the unique benefits of the different effective T1DM management methods?

- What are the challenges of these management methods and how will they affect their actual use-effectiveness?

Literature Review

- The DCCT performed by Nathan, D. M., Bayless, M., Cleary, P., Bergenstal, R., Lachin, J., M., Zinman, B. (2013) showed an improvement in the INT group with the following outcomes: HgbA1C by three to six months to a level of 6.9% from the initial 9.1%.

- The EDIC performed by Nathan, et al. (2013) demonstrated the need for earlier intervention in T1DM by showing that it can reduce severe renal impairment by ~51%, risk of primary CV outcome by 41%, and nontariff MI or stroke by 38%.


Discussion

- Historical studies show that intensive insulin regimens, such as the monitoring of blood glucose and HgbA1C level, provide patients with less long-term microvascular side effects of retinopathy, nephropathy, and neuropathy, as well as the macrovascular side effects of stroke, cardiovascular disease, and cerebrovascular disease.

- Studies have shown that closed-loop insulin pumps can provide better efficacy by monitoring glycemic control according to patient’s blood glucose levels and glycated hemoglobin levels (HgbA1C) and decrease the incidence of hypoglycemic episodes, as compared to the current standard treatment of insulin pump therapy in patients with T1DM.

- Literature reveals that closed-loop insulin pumps have the potential to provide better disease management and improved disease outcomes for those patients who are motivated to use them as directed and find them a desirable option.

- When patients can effectively manage their blood glucose, and practice healthy lifestyle and dietary choices, they can avoid unnecessary hospitalizations and long-term diabetic complications. This will substantially reduce healthcare-related costs, increase longevity and can improve the patient’s quality of life.


Applicability to Clinical Practice

- Initial management of a T1DM patient should include basic disease education, demonstration of SBGM and insulin injection technique. How to recognize and treat a hypoglycemic episode, and how to measure either blood or urine ketone concentrations. In the teaching phase, the patient should be encouraged to include an endocrinologist, a certified nurse educator, dietitian, and possibly a mental health professional to provide support if the need arises.

- As potential future family practice providers, we must consider our patient’s lifestyle, education level, and socioeconomic status to adequately make a choice for their T1DM management regimen.

- SBGM and insulin injections are relatively inexpensive, whereas newer technology is initially more expensive, but provide better efficacy and ease of use and also decrease in hypoglycemic events and hospitalizations. Clinicians must be mindful of what type of insulin delivery system that they are recommending for each patient.

- Closed-loop systems have proven themselves effective; and can lessen disease burden on the patient’s lifestyle. They are appropriate to prescribe for use in patients that can manage them efficiently and are motivated to do so. Closed-loop systems should be considered as a long-term management method in patients with T1DM.

Statement of the Problem

- Current medical treatment for diabetic patients require self-blood glucose monitoring, this monitoring is done using self-blood glucose monitors (SBGM), which results in many finger sticks.

- Insulin injections can be performed by the patient or by an insulin pump that must be manually programmed, which requires the patient to be proficient at calculating insulin doses independently. There is a high potential for error related to insulin administration due to incorrect calibration of the glomerator or basic human error.

- When patients practice good blood glucose management they can avoid unnecessary hospitalizations and other diabetic complications, which will substantially reduce healthcare-related costs. These choices should be based on scientific evidence of effectiveness, not unreliable reports and should be made after considering the patient’s lifestyle and its impact on each method’s particular benefits and challenges.

- The CDC (2017) states that in 2014, a total of 3.5 million hospital discharges and 14.7 million emergency department visits were reported with diabetes being listed as any kind of diagnosis among US adults aged 18 years or older. The total direct and indirect economic cost of diabetes in the US for 2013 was $245 billion; with an average of 730,000 per person being medical expenditures related to diabetes. This is third times higher health-care expenditures for people without diabetes. It is also important to note that DM was the seventh leading cause of death in the US in 2017.

References


- I would like to give a very special thank you to Marilyn Klug, PhD, Barb West, AN-C, Professor Cary Klug, PA-C, Dawn Hackman, and the UND writing center for all their hard work and dedication in helping me to develop and proficiently write this scholarly project. Your time, help and expertise is greatly appreciated, and has not went unnoticed. I also would like to take time to thank the UND Physician Assistant program faculty for their commitment to providing me a quality education and for providing exceptional guidance throughout my endeavors in the PA program.